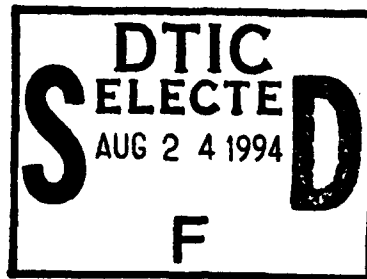


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RAND

*Preliminary Assessment
of Factors Affecting
DoD Facility Energy
Management Capabilities*

Jeff Drezner, Beth Lachman, Melissa Bradley

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PREFACE

The Department of Defense (DoD) is the largest single user of energy in the nation. Although management of that energy is not a primary responsibility of the military services, effective management of both facility and mobility energy can contribute to readiness and sustainability goals, as well as generate potentially significant cost savings. An increasingly tight budget environment is increasing the importance of DoD's energy management capabilities at the same time that reorganizations, downsizing, new business practices, and declining budgets may be adversely affecting the effectiveness of energy policy implementation at the installation level.

RAND is currently engaged in a research project that examines these issues as they relate to management of facility energy at DoD installations. The research is intended to enhance the effectiveness of DoD energy management by defining the context in which DoD energy managers operate, the constraints that they face, and options for increasing policy implementation effectiveness at the installation level. The work reported here is the initial phase of this larger study. After extensive interviews with DoD energy managers, we were able to provide a preliminary assessment of the factors affecting DoD energy management and identify issues requiring further analysis.

This report should be of interest to policymakers and analysts concerned with energy management at federal facilities.

This work was sponsored by the Office of the Deputy Under Secretary of Defense (Logistics), Materials and Resource Management Policy Directorate. The research was performed in the Acquisition and Support Policy Program of RAND's National Defense Research Institute, a federally funded research and development center supported by the Office of the Secretary of Defense and the Joint Staff.

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SUMMARY

The Department of Defense has a facility energy conservation goal of reducing energy consumption per square foot of facility floor area by 20 percent by the year 2000, measured from a 1985 baseline. However, shrinking defense budgets, downsizing and restructuring, and various management reforms are affecting the emphasis placed on energy management at DoD installations. At the same time, DoD is attempting to comply with increasingly stringent environmental regulations, many of which have implications for energy management choices. Unfortunately, the number and quality of personnel available to develop and implement energy policies on installations appear to be declining. How serious is this problem? What capabilities are being lost as DoD loses skilled and experienced personnel? What other factors contribute to these losses in capability?

The work documented here is the initial phase of a larger study designed to address these questions by examining the effectiveness of DoD energy management at the installation level and the factors affecting energy management capabilities. In particular, our long-term objectives are to:

1. Identify existing capability at DoD installations to implement energy policy effectively, and
2. Identify and evaluate alternative ways to cost-effectively enhance that capability.

Phase 1 of this research involved extensive interviews with 43 energy managers at both the Office of the Secretary of Defense (OSD) and service headquarters level as well as at nine installations representing all the services and the Defense Logistics Agency. We were able to document the wide range of activities and responsibilities involved in DoD energy management and to identify factors potentially affecting DoD's ability to implement energy policy effectively and meet its energy

conservation goals. The result of this preliminary assessment of DoD energy management capabilities is documented here.

To a large extent, DoD energy consumption patterns parallel those of the U.S. economy. The size of DoD, the breadth of its activities, and the wide range of fuel types consumed present a serious energy management challenge. This challenge is complicated by the fact that only the OSD Energy Policy office¹ has energy management as a primary responsibility. Further, the incentives facing DoD personnel are quite different from those influencing behavior in the private sector.

Energy management in DoD includes both managerial and technical activities. Managerial activities include formal and informal reporting and tracking of energy consumption and costs; program planning, monitoring, and assessment; submission of requests for project funding; coordination across functional activities, including engineering, maintenance, financial, and contracting; energy awareness and education; and forecasting and projections of energy use and future costs (utility budgeting). Technical activities include project planning, review, and monitoring; energy audits; and project execution (e.g., building retrofit). These activities occur at all levels of DoD energy management to a greater or lesser degree. At the installation level, all of these activities are required. The concept of an "installation energy manager" is an embodiment of these activities in a single individual. Even a full time, well trained energy manager may have difficulty providing all of these energy related services at a large installation.

In discussions with energy managers throughout DoD, several broad categories of issues emerged. These issues correspond with factors affecting energy management capability and the effectiveness of energy policy implementation. The categories are position and organization, training and experience, communications and interactions, resources, metrics and measuring, and others.

¹After the recent DoD reorganization, this function is now located within the Office of the Deputy Under Secretary of Defense for Environmental Security.

Issues concerned with the position of installation energy manager itself include its organizational home, nonstandard job descriptions, high turnover, and lack of a clear career path. The training and experience category includes issues of type and adequacy of training, availability of training funds, and the need to train other relevant functions (e.g., engineering, maintenance, contracting, and finance) in DoD energy policy and practice. The essence of the communication and coordination issues is that an energy manager does not, and cannot, perform his or her job without the support and cooperation of others on the installation. The importance of this aspect of energy management is often overlooked. Resource issues include inadequate numbers of support personnel, a shortage of time to perform all necessary energy management functions, and the need for consistent funding so that program and projects are not interrupted and planning can be improved. Issues associated with metrics and measuring concern the establishment of goals and baselines, measuring performance, and monitoring and tracking. One set of issues did not fall into any of these categories: potential conflicts and synergies between energy and environmental policy and goals, the importance of an effective preventive maintenance program, and the degree to which conceptually good policies are actually feasible to implement when designed.

Generally, the specific issues in each of these areas indicate that energy management effectiveness is constrained in some way. Despite these constraints, we observed that well trained, highly motivated energy managers can (and do) design and execute an effective energy program. We feel that energy and cost savings resulting from these programs could be increased if these constraints were removed or reduced.

Several general observations about DoD energy management emerge from our research to date. We highlight these because they seem to define the key issues and will greatly influence strategies for enhancing DoD energy management effectiveness.

1. Decisionmaking tends to be rather decentralized. This structure seems appropriate to the energy management challenge in DoD, since it allows necessary policy and program tailoring to take place,

but it requires a reliance on highly skilled, experienced, and motivated personnel for effective policy implementation.

2. The reliance on quality personnel also suggests that training and experience are critical to effective energy policy implementation in DoD. Existing training opportunities seem limited, mostly because of the lack of training funds.

3. Implementation of energy policy requires coordination and cooperation of many different functions and activities at the installation level. It suggests that communication and interaction are critical components of energy management.

4. The factors affecting the relative success of energy programs at installations appear to be essentially the same across all services and geographic areas. In general terms, these include command support, resource availability (time, funding, and people), effective maintenance, adequacy of training, and the other specific issues and factors listed above. It is the relative importance of the factors that changes as a function of the unique situation at an installation. The implication here is that there is no "silver bullet" policy option that would alleviate the constraints on effective energy management for all installations.

5. Some potentially very useful DoD energy policies, such as retention of savings from energy conservation projects, are not being effectively implemented. Reasons for this are as yet unclear and require further research.

In general, DoD has made significant progress in establishing an energy management capability in a highly constrained environment. DoD is moving in the right direction to achieve its energy conservation goals. Nevertheless, there appears to be scope for improving the effectiveness of DoD energy policy implementation, with a corresponding increase in benefits in terms of cost savings and meeting environmental regulations.

Future research will address these issues in more detail. Phase 2 includes development and test of a survey tool to gather data on training, activities, and the factors affecting program success, as well as initiation of a policy design case study to gain insight into

implementation barriers. Results should be available in the second quarter of FY94. Phase 3, currently being planned, will expand the survey to all U.S.-based installation energy managers and complete the policy design case study. Phase 3 will identify and evaluate alternative policies for enhancing DoD energy management effectiveness based on the information collected through the survey.

ACKNOWLEDGMENTS

This research would not have been possible without the cooperation of the many DoD energy managers whom we contacted. The open and candid discussions we had with these officials provided insight into issues that we could not otherwise have obtained. The cooperation and participation of these energy managers, at all levels of DoD, are greatly appreciated.

Several federal energy managers deserve special thanks. Millard Carr, the research sponsor, provided important insights and guidance. Jim Patton and Charles Baus, both participants in a special energy manager internship program in the OSD Energy Policy Office, provided access to the personnel and data we needed to conduct this research. Mark Ginsberg and Rick Klimkos of the Federal Energy Management Program in the Department of Energy also provided useful data.

Any remaining errors are the responsibility of the authors.

1. INTRODUCTION

The Department of Defense (DoD) is the largest single energy consumer in the United States, accounting for 1.6 percent of total national energy consumption and approximately 85 percent of total federal government energy use in 1991.¹ DoD consumes the full range of energy types (coal, petroleum, natural gas, electricity, and renewables). DoD energy management is concerned with both mobility fuels (gasoline, jet fuel, etc.) and facility energy (natural gas, electricity, etc.). The management of energy is not part of DoD's primary mission, although effective supply of both mobility and facility energy does affect DoD's readiness and sustainability.

Supplying required energy resources is a relatively small but significant operational cost. Reductions in energy consumption through increased energy efficiency and effective management can produce significant long-run benefits for DoD. In 1991, mobility fuel (petroleum distillates) cost approximately \$6.4 billion and utility energy at installations cost about \$2.9 billion.² An estimated 27 percent reduction in utility energy consumption per square foot of facility floor area over the period FY75-FY85 has resulted in an estimated \$3.8 billion in savings.³ In an environment of decreasing budgets, such savings are substantial. Savings from energy conservation programs can be applied to other operations and maintenance functions, or to programs focused on the general morale and welfare of base personnel. Additionally, energy conservation can facilitate attainment of environmental and pollution prevention goals, an increasingly visible issue for DoD managers.

¹"DoD Energy at a Glance," ODASD(L) Energy Policy Directorate Information Pamphlet, July 1992.

²Data supplied by the Federal Energy Management Program Office, Department of Energy.

³"DoD Energy at a Glance," ODASD(L) Energy Policy Directorate Information Pamphlet, July 1992.

THE PROBLEM

Executive Order 12759 (April 17, 1991) and the Energy Policy Act of 1992 (EPAct92) have mandated certain energy efficiency goals and management actions that require increased attention from DoD officials. The basic utility energy conservation goals are expressed as 20 percent reduction in DoD facility energy consumption per square foot of floor area and a 20 percent reduction in industrial process energy consumption per unit output by the year 2000, measured from a 1985 baseline. Achievement of these goals is assumed to depend on policy implementation at the installation level, which in turn depends on energy management capabilities at installations. EPAct92 reiterates these goals and also mandates that there be a full-time trained energy manager at all DoD installations, and that DoD establish a training program to meet this requirement.⁴

A rapidly changing budget and business environment are affecting DoD's energy management capability at both installation and higher management levels. Shrinking defense budgets result in an increasingly constrained resource environment for energy management. Reforms such as the Defense Business Operation Fund (DBOF) concept and access to external financing for energy projects are affecting the way energy is managed. Further, through downsizing and organizational restructuring, the number and quality of personnel available to implement DoD energy policy appear to be declining.

This is occurring at the same time that overall national energy conservation and awareness are devalued, in part because of low and stable energy prices. Historically, the emphasis that DoD places on energy management has been closely tied to the emphasis placed on energy conservation in the general economy. When political and economic interests in energy conservation are high, the visibility of energy management within DoD increases. Further, public and DoD attention is shifting toward compliance with increasingly strict environmental regulations. It is not clear how these changes will affect DoD's ability to effectively manage energy resources.

⁴Energy Policy Act of 1992, 106 STAT 2857, PL 102-486, Section 157, October 24, 1992.

Despite the potential significance of energy conservation to DoD, there has been little systematic study of policies to cost-effectively manage energy and achieve energy efficiency improvements. In particular, DoD energy policymakers at higher levels in OSD and the services have little knowledge of the implementation of energy policy and programs at the installation level. Congressional hearings have been held on the broader subject of federal facility energy use, but little supporting research has been performed.⁵ Thus, DoD policymaking in this area lacks a strong analytical foundation. This gap in information together with the changing budget and organizational environment raise questions regarding DoD's ability to effectively manage energy use and cost-effectively achieve conservation goals.

OBJECTIVES

This document describes the results of a preliminary assessment of the factors affecting DoD facility energy management capabilities, based on extensive interviews with DoD installation energy managers. This research is part of a larger study examining DoD facility energy management capabilities. In particular, our long term objectives are to:

1. Identify existing capability at DoD installations to implement energy policy effectively, and
2. Analyze alternative ways to cost-effectively enhance that capability.

The first objective relates to defining the energy management challenge in DoD and identifying who is responsible for which energy management functions. An important issue here is identifying the constraints under which installation energy managers operate. The second objective

⁵See *Federal Facilities Energy Conservation Programs*, Joint Hearing before the Subcommittee on Energy and Power of the Committee on Energy and Commerce and the Subcommittee on Environmental, Energy, and Natural Resources of the Committee on Government Operations, U.S. House of Representatives, July 11, 1990; U.S. Congress, Office of Technology Assessment, *Energy Efficiency in the Federal Government: Government by Good Example?* OTA-E-492, May 1991.

involves the identification and analysis of policy options for alleviating those constraints and emphasizing those aspects of installation energy programs that have proved successful, thus making energy policy implementation more effective.

The focus is on DoD capabilities to manage what are often referred to as energy utilities: energy used to heat or cool buildings, or that enables personnel to carry out their functions. We are not examining the management of mobility fuels (e.g., jet fuel), and are only indirectly examining management of industrial process energy. Our focus on facility energy management, which has historically accounted for 20-25 percent of total DoD energy consumption, is due to the increased focus within DoD on installation management, which includes environmental and maintenance issues as well as energy. Consumption of mobility fuels, mostly petroleum-based, is more closely tied to operating and training tempo and requires a different kind of analysis.

This research begins to identify and categorize potential constraints on an installation energy manager's ability to implement energy policy effectively. We present this as a preliminary assessment of the factors that affect DoD energy management capabilities and energy conservation performance. To a large extent, the effectiveness of DoD energy policy is determined by the factors or constraints affecting installation programs, the range of program activities, and the degree of implementation of energy policies.

RESEARCH APPROACH

The overall study has three distinct phases, each providing information necessary for subsequent phases. These are:

1. Preliminary assessment of factors affecting energy management capabilities,
2. Design and test of a survey instrument to obtain information on issues identified in the preliminary assessment, and
3. Full-scale survey of DoD energy managers, analysis of responses, and identification and analysis of options to enhance management effectiveness.

Phase 1 is a preliminary analysis leading to the identification of important issues requiring further analysis. This phase, reported here, consists of a series of interviews with DoD energy managers, defining the characteristics of DoD energy management and identifying key issues requiring further analysis. Phase 2 involves the development of a survey instrument designed to obtain information needed to address the issues raised in Phase 1. A pilot test of 50 installations will ensure that the survey is designed properly and involves a large enough sample to support some preliminary analysis. Phase 2 also includes collection and analysis of data that allow comparison of DoD energy consumption trends to patterns in the U.S. economy and a first-cut statistical analysis of factors affecting DoD facility energy consumption.

In Phase 3, all DoD installation energy managers will be surveyed and their responses analyzed. The resulting database will then be used to evaluate the effectiveness of various options to enhance installation energy management capability. The specific criteria used to evaluate alternatives will be developed as part of Phase 3 and should include a comparison of the costs (management, training, etc.) and benefits (energy savings) of different options. Phase 3 will also expand the statistical analysis begun in Phase 2. Additionally, Phase 3 will include a policy design and implementation case study as a mechanism for identifying barriers to effective policy implementation.

The research reported here describes the first phase and is focused on understanding what energy management means in the DoD context. This includes identifying organizations responsible for installation energy management in DoD, determining how these organizations interact with each other and other organizations both within and outside DoD, determining the specific responsibilities of DoD energy management organizations, and gaining insight into factors that affect (constrain) the effectiveness of DoD energy management. Identification of such factors and constraints is critical to enhancing the effectiveness of DoD energy management, since it suggests areas in which management attention should be focused.

After initial background research and discussions with OSD energy managers, we were able to develop a set of initial hypotheses concerning which factors potentially affect DoD energy management at the installation level. Perhaps most important, we expected to find that the factors affecting or constraining implementation of energy policy at installations would differ as a function of each installation's unique situation. We also expected to find regional and service-based differences in both appropriate energy policies and the way in which those policies are implemented. Because of the size of DoD, we expected a rather decentralized decisionmaking structure with only general guidance from OSD, resulting in considerable tailoring of energy policy at the installation level.

To gather data to address these issues, we held extensive discussions with DoD energy managers at all management levels. These included the OSD office with overall responsibility for energy policy in DoD, the military service headquarters organizations responsible for coordinating that policy, the technical support agencies within the services, and installation managers.⁶ In all we contacted 43 DoD energy managers--23 at the installation level,⁷ five in OSD, and the rest in the component headquarters or support agencies. The installations were not chosen randomly: Since our goal was to learn as much as possible, we generally chose installations that had full-time energy managers who had been in the position at least one year. We also chose installations in different regions throughout the United States to assess whether regional differences in energy policy implementation were present. These were all in-person interviews, often in group sessions that lasted from two hours up to a full day in several cases. Although the discussions were informal, we did have a prepared list of topics we wanted to cover during the course of the interview. These included:

⁶We have not yet contacted energy managers at the command levels.

⁷This included two installations each in the Army and Air Force, three in the Navy, one Marine Corps installation, and one Defense Logistics Agency installation.

- Description of the installation: number and type of buildings, size, population, and activities;
- Energy management at the installation: roles and responsibilities, command and organizational structure, energy staff background, and awareness of energy policies;
- Installation energy program: goals, priorities, activities and program elements, and resources available;
- Implementation of energy program: policy, procedure, and process, relative success, and energy use patterns; and
- Issues and constraints: incentives and disincentives, changes over time, conflicts with other policies, etc.

We generally received high-quality and candid responses from all the individuals with whom we spoke. Upon completion of the discussions, we synthesized all of the responses, first by issue area within an installation and then across all installations visited.

ORGANIZATION OF THE REPORT

In this document, we describe and synthesize the results of our interviews with DoD energy managers. Section 2 characterizes the DoD energy management challenge, provides some context within which the interview results should be interpreted, and characterizes installation energy management in general terms. Section 3 summarizes the results of our interviews, grouping the information into several issue area categories: position and organization, training, communication and interactions, resources, metrics and measuring, and other issues. Section 4 draws several general observations from these results, and briefly describes the next step in this ongoing research.

2. CHARACTERIZING DoD ENERGY MANAGEMENT CAPABILITIES

This section briefly characterizes the DoD energy management challenge and presents a preliminary assessment of the current status of DoD energy management. Information supporting this discussion derives in part from our discussions with OSD and component-level energy managers as well as several DoD and Department of Energy (DoE) databases, regulations, and reports.

THE CHALLENGES OF DoD ENERGY MANAGEMENT

The challenges of DoD energy management relate to the wide range of fuel types DoD consumes in its activities, DoD's large size, the breadth of its activities, and the necessity for decentralized decisionmaking.

The types of energy DoD consumes and the use to which the energy is put are at least as varied as any commercial organization. In terms of energy consumption patterns, DoD appears to be a microcosm of the U.S. economy. Figure 2.1 shows total DoD energy consumption by end-use sector. Vehicles and equipment dominate energy consumption in DoD. These are mostly petroleum distillates, and jet fuel accounts for most of the energy consumed in this category. Industrial process energy has historically accounted for only a few percent of the DoD total, whereas facility energy has accounted for between 20 and 25 percent of the total. Only facility energy use has shown a decreasing trend over this 16-year period.

Figure 2.2 shows the corresponding cost figures for the energy consumed. Again, vehicles and equipment account for the largest proportion: in 1991, this was \$6.4 billion of a total cost of \$9.3 billion. The very large proportional increase in vehicle and equipment energy costs over the period 1978 through 1985 corresponds with increases in oil prices experienced over this time period. Vehicle and equipment energy--mobility fuels--are mostly petroleum distillates and so costs are highly sensitive to oil prices. Interestingly, the cost of facility energy (in constant dollars) has been rather flat since the

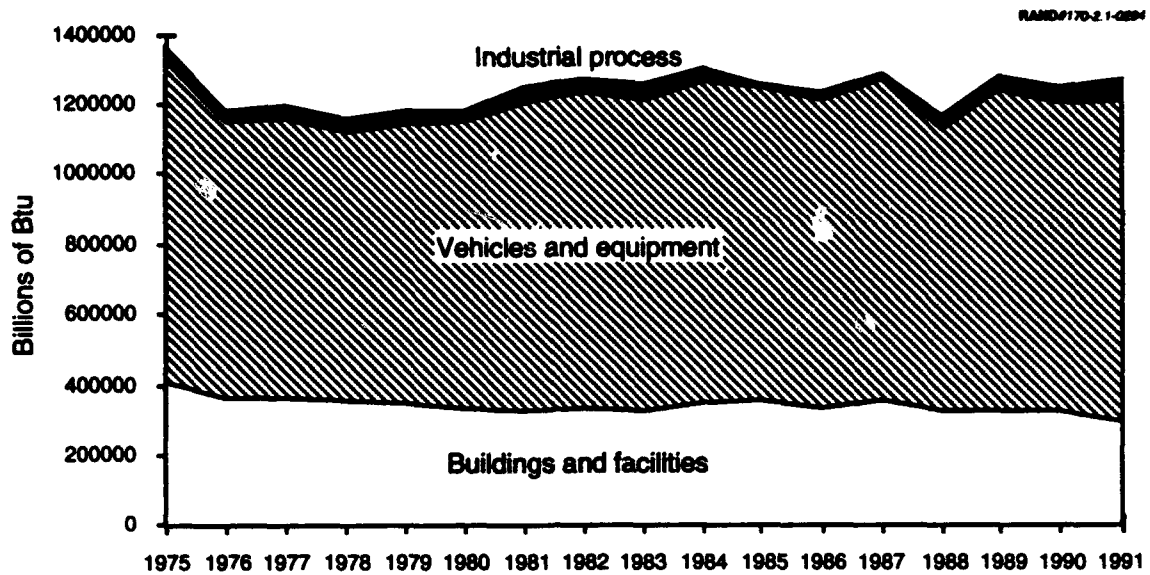


Figure 2.1-DoD Energy Consumption by Sector

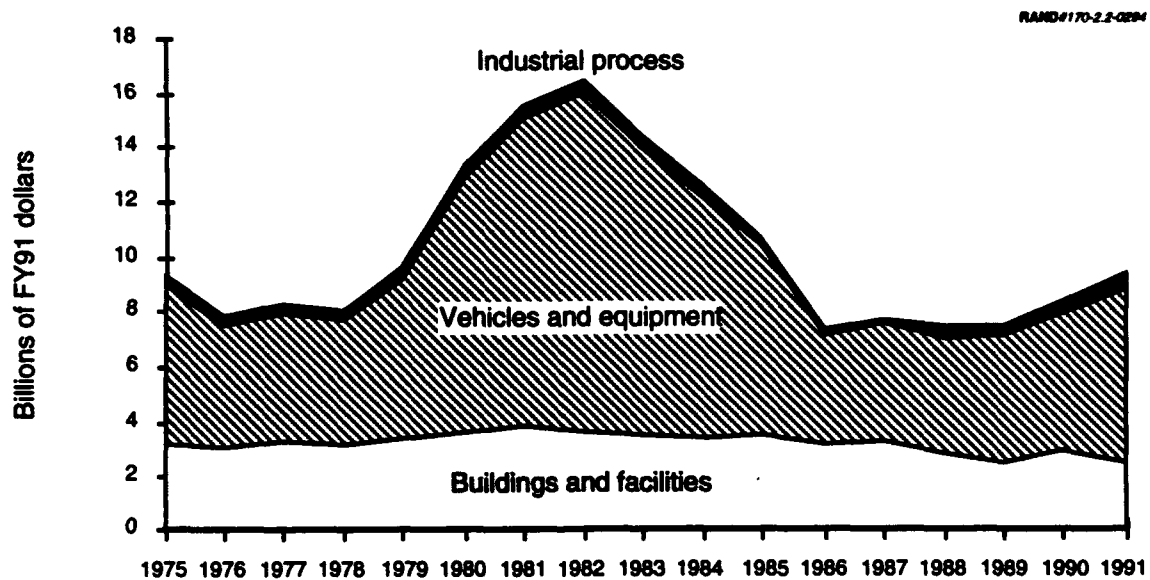


Figure 2.2-DoD Energy Costs by Sector

mid-1970s, despite the decrease in total energy consumed. Increases in energy prices can account for this difference.

Figure 2.3 provides some detail on facility energy costs over time. Electricity has historically cost more than any other fuel type, and both the absolute cost and the proportional cost of electricity have

grown over time. In 1991, electricity costs were 67 percent of total facility energy costs, up from 54 percent in 1975. At the same time as electric energy costs were increasing, fuel oil costs have decreased dramatically, from \$811 million in 1975 to \$402 million in 1991 (constant FY91 dollars), a proportional decrease of 15 percent of total costs.

In large part, these energy cost trends are driven by changes in consumption over time, rather than by changes in energy prices. As Figure 2.4 shows, electricity use has increased substantially as a proportion of the total, from about 20 percent in 1975 to 34 percent in 1991. Increases in electricity use can be attributed to increased availability of air conditioners, computers, and other electric appliances. Fuel oil consumption has decreased dramatically since 1975, from 38 percent of the total to 20 percent in 1991. To some extent, this decrease is due to conversion from fuel oil to natural gas for some energy uses (e.g., steam and hot water generation, and room heating), which accounts for the slight increase in natural gas use.

An important trend for our purposes here is the notable overall decrease in facility energy consumption. Since 1975, total facility energy use in DoD has dropped by about 29 percent, although the trend has not been entirely smooth, and as noted, consumption of electricity and natural gas has increased in absolute terms. Energy management capabilities, in the form of effective conservation efforts, are in part driving the downward trend in overall energy consumption.

Managing DoD facility energy presents difficult challenges. As the data just presented demonstrate, the types of energy DoD consumes, and the particular uses of that energy, are at least as varied as those in any commercial organization.¹ Further, the incentive structure facing energy managers and personnel in DoD is different from that of the commercial marketplace. To some extent, DoD consumption is insensitive to changes in energy prices, because energy is only a small portion of

¹As part of ongoing research, data that will allow comparison of DoD energy use patterns with those of the U.S. economy and private sector organizations are currently being collected and analyzed. Detailed quantitative results will be available in future reports documenting the latter phases of this study.

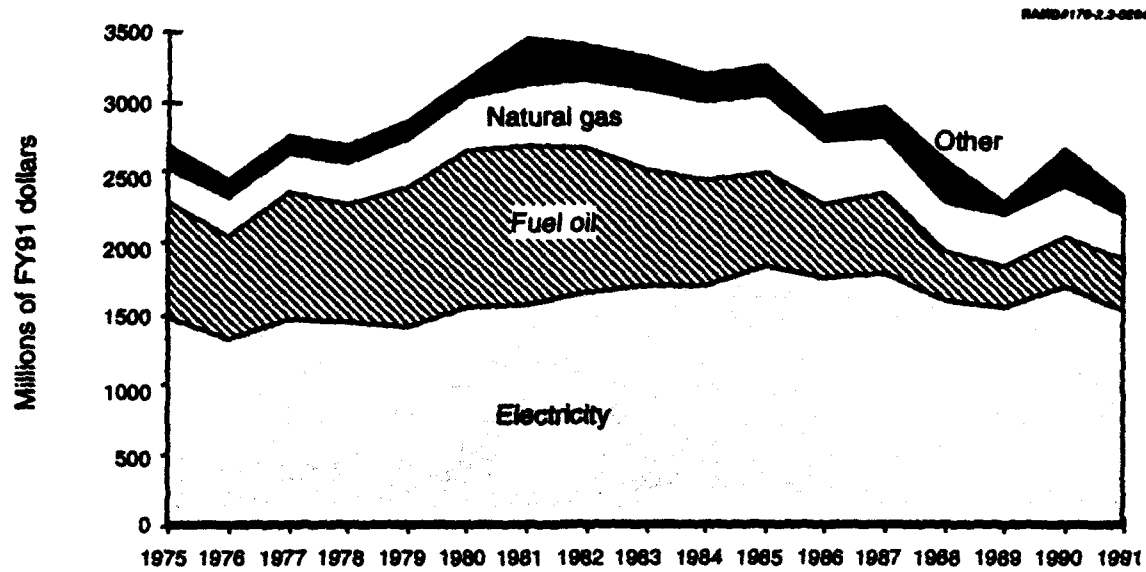


Figure 2.3—Cost of DoD Facility Energy

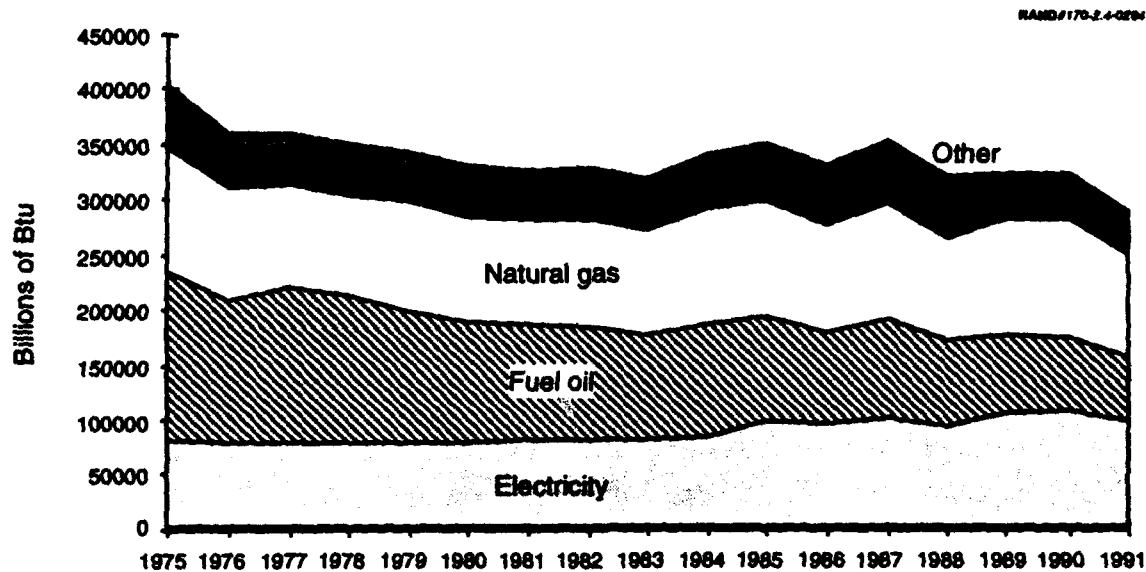


Figure 2.4—DoD Facility Energy Consumption

the costs for any particular activity, and these costs are often not visible to installation commanders and other personnel. Related to this is the fact that the OSD energy policy office is the only organization in DoD whose primary mission is energy management. Other characteristics of DoD that complicate energy management include the

large size, complex multiagency institutional structure, and wide ranging geographic distribution of DoD. These characteristics require a decentralized decisionmaking structure for energy policy implementation, which means that policy coordination and implementation across different organizations become critical to successful energy management.

If it was only DoD energy policy and management capabilities that affected DoD energy use and ability to achieve its energy goals, then the challenge would be more easily managed. However, a wide range of factors affect DoD's ability to achieve facility energy management goals. One set of factors, entirely external to DoD, includes energy prices, technology development to facilitate conservation, and general interest in energy conservation. There is another set of factors internal to DoD but beyond the scope of an energy manager's responsibility or influence. These include personnel or population changes in DoD or on a particular base, changes in activity rates and missions, and the age of buildings and equipment. The degree of command support and the funding and quality of maintenance are not direct responsibilities of installation energy managers but can sometimes be influenced by them.

Thus, DoD energy management capability is only one of many influences on DoD energy performance. Careful analysis is required to determine the relative importance of these sets of factors on DoD's ability to achieve its management goals.²

CHARACTERISTICS OF DoD FACILITY ENERGY MANAGEMENT

The large size of DoD, the wide range of activities, and the range of fuel types consumed necessitate a decentralized energy policy decisionmaking structure. This is in fact the kind of organizational structure we observed. Generally, there is a single policymaking organization in OSD and various agencies within the services that either implement policy or provide various types of technical support. Regulations are written in a way that facilitates tailoring energy

²Other aspects of the research, not reported here, have begun to examine this issue. It will be more thoroughly explored in subsequent phases of the research.

policy to the unique requirements of the services, commands within the services, and specific installations. This structure suggests that effective policy implementation requires high-quality energy management personnel throughout the implementation chain.

There are distinct differences between the services. For instance, the Army seems more centralized than the other services, with a higher degree of coordination between the support agencies, commands, and installations. The Army also seems to place a higher priority on energy management. The Navy is the only service that operates the equivalent of a commercial utility in its regional Public Works Departments. The Navy also seems well equipped to provide technical support directly to installations through the Engineering Field Divisions of the Naval Facilities Engineering Command (NAVFAC). The Army offers several energy management training courses, the Navy offers a few, and the Air Force, Marine Corps, and Defense Agencies make use of these. At the installation level, the energy management function is located within a wide range of organizations, some of which tend to be service specific. All services have a base civil engineering function which either is the home for the energy management activity or provides technical support.

In general, the visibility of energy management is fairly low throughout DoD. This is not necessarily a reflection of the efforts of energy managers but rather reflects the fact that energy management is not a primary mission for DoD. In fact, managers have made considerable progress in increasing energy awareness.

As in the commercial world, a full range of conservation program options are available to the installation energy managers. These include both contracting and financing alternatives (demand side management, shared energy savings, etc.), energy audits, retrofit projects, and energy awareness and education. Use of some of these options, particularly the contracting and financing alternatives, does tend to be relatively constrained compared with a commercial organization. Further analysis is required to determine whether this is because DoD must follow government policy and procedures, or whether factors internal to DoD result in unintentional constraints.

Resources available for energy management appear to have declined over the last decade or so. This seems to be the case for both personnel and funding. Personnel levels have generally dropped significantly from the late 1970s and early 1980s, from multiple installation personnel with energy as a primary function to just one (sometimes a fraction). At the same time, personnel concerned with environmental compliance and restoration have increased significantly, although it is not the case that personnel are shifted directly from energy to environmental activities. Resources for both energy management and conservation projects declined to almost nothing by the late 1980s. However, recent funding made available through Defense Management Report Decision (DMRD) 907 and the Energy Conservation and Investment Program (ECIP) has turned this trend around significantly. The increase in funding availability was widely applauded by the energy managers we contacted.

Energy management activities are quite varied and consist of both managerial and technical activities. Managerial activities include:

- Formal and informal reporting and tracking of energy consumption and costs.
- Program planning, monitoring, and assessment.
- Submission of requests for project funding (e.g., ECIP).
- Coordination across functional activities, including engineering, maintenance, financial, and contracting.
- Energy awareness and education.
- Forecasting and projections of energy use and future costs (utility budgeting).

Technical activities include:

- Project planning, review, and monitoring.
- Energy audits.
- Project execution (e.g., EMCS and building retrofit).

These activities occur at all levels of DoD energy management to a greater or lesser degree. At the installation level, all these activities are required. The concept of an "installation energy manager" is an embodiment of these activities in a single individual. Even a full-time, well trained energy manager may have difficulty providing all of these energy related services at a large installation.

Our preliminary assessment suggests that current energy management capabilities are varied. As suggested in Figure 2.3 earlier, DoD is moving in the right direction to achieve facility energy conservation goals. To date, about a 10 percent improvement from the FY85 baseline has been achieved. Although the decentralized structure of energy policy and management in DoD seems appropriate, the resulting reliance on high-quality personnel at the installation level is problematic. There are some highly effective energy managers at the installation level. However, there are also some less than effective energy programs, for a variety of reasons that require further analysis. We also found that DoD's basic energy policies address a wide range of relevant areas: We found no large gaps in basic policy. However, there appears to be room for some changes in certain policies to make implementation more effective.

ENERGY CONSERVATION INCENTIVES IN DoD

It is important to pause here and briefly discuss the differences between DoD energy management and the private sector. These differences are inherent in DoD as a government organization and imply that the tools available to DoD energy managers are somewhat different from those available in the private sector. More specifically, the mechanisms for accomplishing energy conservation and efficiency improvement may be very different. This difference in large part derives from the difference in incentive structures between DoD and the private sector.

In the private sector, incentives to conserve energy either by using less or by increasing the efficiency of use are highly sensitive to energy prices. Thus, increasing the price of energy will motivate behavioral and/or technological change, resulting in increased energy efficiency (reduced BTUs per unit output) and energy conservation

(reduced consumption).³ The reduction in energy consumption and increased efficiency of energy using equipment in the late 1970s through the 1980s are in large part attributed to increased oil and other energy prices. Higher oil prices stimulated increased demand for more energy efficient vehicles in the late 1970s.

The incentive to conserve energy in these cases is provided by a market mechanism in which the price of energy is a visible operating cost. No such mechanism exists in DoD. Energy users--building occupants, equipment operators and maintainers, military family housing--are generally not aware of energy consumption and are not responsible for paying utility bills. Those at higher levels within the base hierarchy are aware of energy consumption, but there is no direct linkage between them and the energy user.

Further, the incentive to conserve does not operate in the same way. In the private sector, the benefits of conservation can be captured by the individual or the organization that increased efficiency. In DoD, savings from energy conservation would generally be returned to higher levels at the base, service, or DoD. The annual appropriation process, which is very much incremental (next year's budget is not likely to differ much from last year's), may even penalize conservation behavior. If a base reduces expenditures for energy in a given year, next year's appropriation may be smaller by that amount, since it is obviously not needed to pay for utilities.

This issue of incentives in DoD to conserve energy seems fundamental to the issue of achieving energy consumption goals. Effective incentives need to be part of the energy manager's installation energy plan. This issue will be addressed in future research.

³There is a large literature providing theoretical and empirical support for the importance of incentives and the relationship between energy prices and consumption. See, for instance, Michael Shepard, "How to Improve Energy Efficiency," *Issues in Science and Technology*, Summer 1991, p. 85; Amory B. Lovins, "Four Revolutions in Electric Efficiency," *Contemporary Policy Issues*, 1991.

3. ISSUES AT THE INSTALLATION LEVEL

This section describes our preliminary analysis of DoD installation energy management capabilities. Our basic objective is to identify the factors that may affect DoD energy management and policy implementation at the installation level. We have not attempted a definitive analysis: Such analysis requires an improved database in terms of both quality and scope. Nevertheless, available data and preliminary analysis suggest areas in which later phases of the study should focus.

As mentioned earlier, this preliminary analysis is based on discussions with 43 DoD energy managers at different levels. The specific results presented in this section rely heavily on our discussions with 23 installation energy managers. For the most part, we have focused on those issues that appeared relatively more important to more than one energy manager. There was a surprising amount of agreement among the energy managers we contacted. We present the results of these discussions by issue area category.

POSITION AND ORGANIZATION

Installation energy managers have a variety of roles and responsibilities: record keeping and reporting, energy awareness programs, construction project review, submission of technical data packages for energy conservation projects, and technical energy audits. Most of the installation energy managers we spoke with had energy management as a formal responsibility, although many spent less than full time on this task. In some cases, energy management was "other duty as assigned." The organizational home for the energy management function was usually within the base civil engineering, public works, or facility maintenance organizations, depending in part on which military service occupies the base. All installation managers we spoke with took the job seriously and attempted to design and implement an energy conservation program tailored to their installation with whatever resources were available. As implied by the aggregate energy trend data, most installations are meeting their energy reduction goals,

although at this level, trends are not smooth. Large variations in energy consumption can occur because of abrupt changes in activity rates, population, or reorganizations.

There is no standard, formal job description for an energy manager, either across services or between installations within the same service (or in the same geographic area). Service regulations define a broad set of responsibilities, but actual and specific activities vary considerably at the installation level. In general, pay grades are low, perhaps too low to attract and keep quality personnel for extended periods. In short, there is no career path for energy management within DoD (true also at levels above the installation). This is an important disincentive to current managers and represents a significant constraint on effective implementation of energy policy.

Turnover can be high, which implies a loss of accumulated skills and experience in the energy manager function. Although the factors driving turnover require further analysis, frequent energy manager turnover hinders effective policy implementation because the energy program at an installation effectively starts over each time there is a change in personnel.

The energy management function can be thought to encompass two related sets of activities. The first is managerial and public relations oriented. It includes tracking and reporting energy use, designing installation energy programs, fostering energy awareness, responding to external requests for information, and most important, overseeing and coordinating the other functions and activities required to execute policies and programs. The second function is more technical and includes project design and development, project review, monitoring, and audit. Generally, aspects of both energy management functions are required in submittal for energy project funding (e.g., Energy Conservation and Investment Program [ECIP], Demand Side Management [DSM], Shared Energy Savings [SES]). There was some consensus that the administrative functions are the core of the energy management job and should be located as a staff function of the commander to increase visibility and help coordinate other functions. There is a similar consensus that the technical aspects of energy management properly

belong within the base engineering function. At some installations, the energy management function is in fact divided in this way and appears to be successful.

TRAINING AND EXPERIENCE

An effective installation energy manager needs both general energy management training and training in specific activities appropriate for the installation. General energy management includes basic principles of energy conservation, life-cycle costing, and a familiarity with OSD and service level policies, procedures, and opportunities (e.g., funding sources). Specific activities include building energy conservation, DSM, SES, ECIP, energy monitoring and control, thermal storage, lighting retrofit, etc. We found that training is available in both categories through seminars and workshops sponsored by both government and private sector organizations. However, training funds are extremely scarce and have decreased in the last few years, limiting energy managers' ability to make use of these training opportunities. Skills are mostly acquired on the job. The type of program activities emphasized by the installation manager appeared to reflect the training and background of the individual. Although there appears to have been a move toward improved training even before the EAct92 requirements, several energy managers received no training at all before assuming energy management responsibilities.

One of the most important requirements of an installation energy manager--communication and coordination across activities--is not included in any formal training course. Interestingly, it is also not listed as a requirement for a "trained energy manager" in EAct92. Rather, EAct92 defines a trained energy manager as one who has completed formal study or demonstrated proficiency in building energy systems, energy codes and applicable professional standards, energy accounting and analysis, life-cycle costing, pricing, and instrumentation for energy surveys and audits.¹ There is no mention of the truly management aspects of the energy management function,

¹Energy Policy Act of 1992, 106 STAT. 2844, Sec. 151.

including planning, coordination across activities, and eliciting cooperation of personnel.

In fact, despite their obvious knowledge and relative success in implementing energy policy, very few energy managers in DoD at any level meet the definition of "trained" used in EPAct92. This has resulted in widespread concern among existing managers that their past performance and accumulated knowledge are being improperly discounted.

Training also needs to include personnel in other activities and organizations--at least legal, contracting, maintenance, and financial activities. For instance, a DSM program cannot be implemented at an installation unless personnel in contracting and financial organizations are familiar with the policy and procedure of DSM. Maintenance personnel need to be trained in proper preventive maintenance techniques to sustain whatever gains are made through energy conservation projects. Financial personnel need to better understand the principles of life-cycle costing, which is required by law and properly includes the costs of energy.

An interesting concept that deserves thorough consideration is some type of apprenticeship or intern program. A model for this already exists in the Energy Management Professional Enhancement Program, which allows installation energy managers to work within their service headquarters and OSD energy offices for a year. A broader based apprenticeship program would allow development of a cadre of energy managers from which DoD could draw.

COMMUNICATIONS AND INTERACTIONS

The energy manager's position is highly interactive and requires substantial "people skills." Generally, the energy manager does not, and cannot, perform all tasks associated with energy activities. The cooperation and participation of personnel from legal, financial, contracting, engineering, and maintenance organizations are required for effective implementation of energy policies and programs.

The energy manager has no authority over these other functions, and the personnel within these functions are not graded (subject to performance evaluation) on their energy activities performance. Thus,

installation personnel have no incentive to develop conservation behavior. Some energy managers suggested that all personnel on base, from support functions to the operational forces, be graded to some degree on their energy performance. It was also clear that a good energy awareness program can overcome this problem to some extent. Energy awareness programs that include periodic contests with small monetary awards can encourage good energy practices in personnel who might be otherwise uninterested or unmotivated to conserve energy.

Many energy managers stated that the support of the base commander is essential for effective energy program implementation. The base commander can provide incentives to support personnel through personnel evaluations, and can set a good example of energy conscious behavior. The commander can also set priorities and make resources available for energy conservation. Lack of base commander support, indifference, or active repression will reduce the effectiveness of installation energy programs.

Another aspect of communication and interaction concerns information and technology transfer between installations. There is considerable energy management experience within DoD, with some managers having particular expertise in certain areas. Currently, information sharing takes place at the occasional energy seminar or workshop. These are considered both important and useful events by energy managers, but the infrequent workshops limit opportunity for information exchange. There is no formal mechanism for information sharing within DoD.

RESOURCES

Resources available to implement energy policy at the installation level have decreased steadily since the early 1980s. Funding for energy conservation projects declined to essentially zero in the late 1980s. In the early 1990s, this trend began to be reversed. Defense Management Report Decision (DMRD) 907 made significant O&M funds available for energy management at all levels within DoD. The ECIP program (using military construction funds) was reestablished, with \$10 million in FY91, \$30 million in FY92, and \$50 million in FY93-FY97. Such increased

funding has been of considerable benefit to the effectiveness of energy management in DoD.

Nevertheless, there remain funding problems. One issue is a "flavor of money" issue in which O&M and Milcon funds cannot be transferred between accounts, even though the activities to be funded are very similar. This often hinders project execution. A long-term commitment of funding resources is also needed: Installation managers have difficulty predicting funding availability for projects, and so have difficulty planning projects and obtaining command support. Similarly, a long-term commitment of funding resources to maintenance would benefit the energy program: Maintenance funds are often reduced in a tight budget environment.

An important resource related issue concerns developing an economic justification for energy conservation projects. Life-cycle costing (LCC) is the required method and should be sufficient, but in some cases LCC has not been done properly. Often this results in a determination that an energy project does not have a sufficient payback to warrant implementation. A related issue concerns the payback time-frame of energy projects. Large-scale energy projects may require significant funding up front and accumulate benefits over time. Since installation commanders generally rotate every two years, projects that have payoffs in excess of one or two years are often not approved.

Many installation energy managers believe that there are generally too few dollars to support a comprehensive energy conservation program. One suggestion is to create a pool of funding for installation managers to support energy awareness and similar, inexpensive activities.

Two fairly recent policies would potentially supply significant and sustained funding to energy programs. These programs are structured in such a way as to provide incentives for continued energy conservation behavior. One is a policy in which dollars generated through the base recycling program are used for the energy program. At least one installation we visited has successfully used this source of funding in support of energy awareness activities. Another is the recently legislated retention of savings policy in which two-thirds of the total savings from energy projects can remain at the installation level, one-

half for use in general morale and welfare activities and one-half for use in the energy program. Neither of these funding sources is used consistently; neither policy is well implemented.

An important resource problem is personnel availability, both the lack of sufficient supporting personnel and a shortage of time to perform the energy management functions. The range and scope of energy management responsibilities requires at least one full-time individual. Even then, it is often difficult to participate in time-consuming but valuable programs like ECIP. ECIP's 35 percent complete design criterion and requirements for detailed project plans and justification are time-consuming, requiring personnel resources that are often not available. Many energy managers suggested that a shortage of personnel in supporting functions was a problem. Sometimes a billet for a position is available, but a government hiring freeze makes it difficult to fill. Most energy managers also mentioned a decrease in personnel with energy related responsibilities in the last few years.

There is an important issue linkage between the number of personnel with energy related responsibilities and the quality of their training and experience. Because of the decrease in supporting personnel, a single individual must now have the knowledge and skills of the several individuals who performed some energy related functions in the past. This highlights the importance of training in effective energy management, especially in an environment of reduced resources. To some extent, adequacy of training and experience can compensate for the decrease in personnel.

Broadly defined, resources may include buildings and equipment as well as personnel and funding. Buildings and equipment are often old and not well maintained, reducing efficiency and limiting the options available for energy projects. For instance, the electrical systems in some buildings will not support a lighting retrofit without substantial and costly modification.

METRICS AND MEASURING

There are two basic issues in this category: baselines and goals, and metering.

Current DoD energy conservation goals are perceived as unfair by energy managers at installations that have reduced energy consumption in earlier periods. The basic goal--20 percent reduction from a 1985 baseline in energy per square foot--is applied across the board without consideration of the scope for energy conservation at an installation. Many installations achieved significant improvements over the period FY75-FY85. They claim to have already done all the no-cost/low-cost measures, making future conservation efforts both more difficult and more expensive per energy unit saved. Further, many installations have rapidly changing populations, activities, and missions which affect energy use. The current perceived lack of consideration of these factors in establishing goals is a major disincentive, especially to energy managers who were active in the prior period and have received little or no recognition for past efforts and success.

A related issue concerns defining goals. Although the official goal is expressed in terms of energy reduction, it is dollar savings that motivate action. It is sometimes the case that these goals conflict: It is possible to save energy at a cost higher than the value of the savings, and it is also possible (through peak demand shifting for instance) to generate cost savings without saving energy.

Metering is important in tracking energy use, measuring improvements from a baseline and progress toward a goal, and estimating future utility costs. Most installations are not metered at the building and facility level. Thus there is no way to accurately track energy use across the installation. This is a major problem, since it is very difficult to manage what you cannot measure. Metering would provide incentives to building occupants to conserve, would improve the accuracy of utility estimating and billing, and would allow identification of the scope for improvement in specific areas. Metering is also required to properly implement DBOF and the retention of savings policy. The alternative to metering is engineering estimates, which are both more time-consuming and less accurate.

OTHER ISSUES

A range of other issues arose in our discussions that do not fit easily into the categories above. These include the relationship of energy and environmental functions, the importance of preventive maintenance, military family housing, utilities, and policy design and implementation issues.

There appears to be little inherent conflict between energy and environmental goals. Some energy managers had examples of conflicts that were later overcome, but these conflicts had their source in general procedures and lack of sufficient planning and coordination, not because goals were in conflict. In fact, energy and environmental goals are often complementary. Significant opportunities for synergy exist, as in the case of converting a boiler using coal or fuel oil to natural gas, thus avoiding the cost of scrubbers and reducing the costs of energy and maintenance. Energy policy resources are not directly drawn off and applied to environmental compliance, although the basic competition for resources that exists between all programs in DoD exists here as well. Environmental compliance is emphasized over energy because of the legal requirements and specificity of environmental regulations. Noncompliance with environmental regulations can result in significant fines, or even jail. There is no such penalty for energy noncompliance.

Preventive maintenance is necessary and critical for success in energy conservation. Effective maintenance will reduce loss (waste) and keep equipment operating at peak efficiencies. There is currently little or no training or incentives for a continuous preventive maintenance program.

By some accounts, military family housing uses approximately 2-4 times as much energy per unit as similar households in the private sector.² The reason appears to be the lack of awareness of energy costs: Occupants neither see nor pay for utility bills, and thus have no incentive for conservation. In fact, the bad energy habits practiced at home can get transferred to the workplace. Since military family

²This assertion will be tested in subsequent phases of the research.

housing consumes a significant portion of energy use for some installations, the problem requires further consideration. Military family housing is often treated as a protected benefit of military service by both DoD and Congress. Thus, there is currently little that an installation energy manager can do to affect energy use in military family housing.

Another issue mentioned by several energy managers concerned their local utility. Utilities often provide inexpensive energy management support and free audits and are a critical aspect of the DSM concept. If the utility is uncooperative, because of either lack of interest or poor relations, several potentially beneficial energy project options are foreclosed.

Last, some policies seem ill-designed and poorly implemented in the field. The requirement that ECIP projects be 35 percent design complete and the lack of funding for this effort before obtaining ECIP funding are examples of poor policy design. The fact that the retention of savings policy is not being implemented in the field illustrates the difficulties of following through even on policies with considerable potential benefits. Part of the problem here lies in increasing the cooperation and coordination between organizations within DoD. In the case of the retention of savings policy, improved coordination between energy and financial management functions is necessary.

4. OBSERVATIONS AND FUTURE RESEARCH

DoD is generally on track to meet its energy reduction goals. Energy efficiency appears to have improved by about 10 percent since 1985, about half the required amount. Nonetheless, DoD's large size, breadth of activities, and variety of energy used present a continuing challenge for DoD energy managers at all levels.

Judging by the results of our interviews with DoD energy managers, we can identify several general observations and lessons about DoD energy management which appear to be fundamental to the issues. We highlight these here because we believe that they define the fundamentals of the problem and will thus influence the nature of potential solutions.

1. Decisionmaking tends to be rather decentralized. This structure seems appropriate to the energy management challenge in DoD, since it allows necessary policy and program tailoring to take place. Decentralized decisionmaking means that effective policy implementation relies on high-quality personnel throughout DoD. We found that DoD energy managers are generally capable, knowledgeable personnel working within a highly constrained environment.

2. The reliance on quality personnel, and the fact that the number of personnel with energy related support roles has decreased, suggests that training and experience are critical to effective energy policy implementation in DoD. Existing training opportunities seem limited, mostly because training funds are not available, nor is a comprehensive formal and standardized training program in place. Further, there is little emphasis on important managerial responsibilities.

3. Implementation of energy policy requires coordination and cooperation of many different functions and activities at the installation level. This is perhaps the most important, and most difficult, responsibility of an energy manager. It suggests that communication and interaction are critical components of energy management. This notion is not yet recognized either in formal policy documents or in training programs.

4. The factors affecting the relative success of energy programs at installations appear to be essentially the same across all services and geographic areas. These include command support, resource availability (time, funding, and people), effective maintenance, adequacy of training, and effective communication--generally all of the specific issues discussed in Section 3. Energy programs at all installations are constrained to some degree by all these factors. It is the relative importance of the factors that changes as a function of the unique situation at an installation. The implication here is that there is no "silver bullet" policy option that would alleviate the constraints on effective energy management for all installations.

5. Some potentially very useful energy policies, such as the retention of savings policy, already exist within DoD and can alleviate some of these constraints. For instance, the retention of savings provides a particularly effective incentive encouraging conservation efforts in a time of highly constrained budgets. However, the policy is currently not being implemented effectively and thus falls short of its potential. Implementation bottlenecks and inconsistencies reduce the effectiveness of energy management.

After our initial discussions and preliminary analysis, we can identify a set of energy program characteristics or dimensions that appear to significantly affect the relative success of installation energy programs. Although preliminary in nature, a successful installation energy program would have most of the following characteristics:

- Full-time energy manager located within the base commander's staff.
- Visible command support.
- Broad-based and frequent training for both the energy manager and key support personnel.
- Cooperation and participation of key elements of the engineering, maintenance, financial, and contracting functions.
- Continuous preventive maintenance program.
- Continuous and viable energy awareness programs.

- High degree of implementation of funding related energy policy (e.g., recycling and retention and savings).

We would expect some variation across these dimensions and that installations with relatively more of these characteristics would achieve relatively higher conservation performance. Such notions need to be explored further.

On the basis of our research to date, we have identified the following issues as requiring further focused analysis in the near term:

- Formalization and standardization of energy training.
- Policy coordination and implementation constraints.
- Relationship of factors affecting energy policy implementation to program outcomes.
- Identification of program activities and characteristics associated with successful installation energy programs.

We have designed a three-part research effort to address these issues. First, a policy design and implementation case study should be conducted, focusing on the retention of savings policy. This would allow insight into the implementation process and incentives affecting energy management, as well as the identification of important bottlenecks to effective implementation. Second, a survey of DoD installations should be conducted, focusing on collecting information on training, program activities, and the relative importance of constraints. This information cannot be obtained in any other way and would be very useful in designing an energy management training program and determining issue areas in which increased or reallocated effort by the OSD energy policy office might have the greatest effect. Last, a statistical analysis of factors affecting energy conservation should be performed, at both the aggregate and detailed (regional) level. This would be an attempt to quantify, or at least rank order, the program activities and characteristics with the greatest effect on energy conservation performance.

Our Phase 2 research effort has begun to pursue this strategy, including a pilot survey of 50 installations that will both inform the broader survey intended as the core of Phase 3 and allow a preliminary analysis of important training and management constraint issues. As previously mentioned, the larger survey in Phase 3 is intended to gather the data needed for a more definitive analysis of training requirements and the factors affecting DoD energy management. Phase 3 will identify and evaluate alternative strategies for enhancing energy management capabilities, using the results of the survey, policy design case study, and statistical analysis of factors affecting energy program outcomes.

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